

LIFE-HISTORY OF THE PROTHONOTARY WARBLER

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DURING the years 1937 through 1945, I studied the Prothonotary Warbler (*Protonotaria citrea*) in an area along the Battle Creek River in Convis Township, Calhoun County, Michigan. The area consisted of the winding river and adjoining bottomlands and was nearly two-thirds of a mile (1069 meters) long (about 9460 feet or 2859 meters by river) and approximately 88 acres (35.62 hectares) in area. During the war years fewer trips were made to the area but enough search was made to identify the banded birds.

Much of the information obtained in my first year's study was published in *Bird Banding* (1938, 9:32-46); additional information, on the 1938 season, in *The Jack-Pine Warbler* (1939, 7:64-71); and a comparison of the studies made in Michigan and at Reelfoot Lake, Tennessee, through 1940 was published in *The Wilson Bulletin* (1941, 53:3-21). Since I was unable to visit the Tennessee area after 1940, I was not able to get information on the banded birds which were studied there during 1939 and 1940. This paper deals almost entirely with the Michigan birds. Table 1 gives the first date Prothonotaries were observed at Battle Creek and the date of the first-laid egg, for each year.

TERRITORY

Upon arrival on the Michigan nesting grounds, the male Prothonotary Warbler immediately stakes out his territorial claim. I have never found a territory in other than the immediate vicinity of well-shaded water, either running or in stagnant pools. Of 84 nests found in "natural" locations, 29 were over standing water, 32 along the edge of running water or over it, and the remaining 23 over dry land. The last 23 were from .61 to 137.8 meters from the river bank and usually in easily flooded spots. Nearly all of the nests were shaded most of the day. In one nest, upon which the mid-day sun shone during the nestling period, all of the young died one hot afternoon. There are other requisites besides shade and water for a good nesting site. The sites are usually not very high. Where bird houses were used, I found the birds preferred sites between one and two meters above the water, but would nest in houses whether they were only a few centimeters above the water or three or four meters high. Of the nests located in natural sites, 43 were in various cavities and 41 in woodpecker holes. Downy Woodpecker (*Dendrocopos pubescens*) holes were preferred. Forty-one nests were located from 61 to 152 cm. above the ground or water; 21, between 152 and 304 cm.; 20, between 304 and 450 cm.; and two even higher. The highest nest was 10.4 meters above ground.

I usually found the first male of the year in the early morning. Often there had been no bird in the same place the day before. At first, territories were rather large, taking in great stretches of river. As other males arrived, battles ensued, the new males each finally taking possession of some restricted water frontage and the earliest male trying to retain as much as



FIG. 1. Nesting habitat of Prothonotary Warbler in Calhoun County, Michigan. One pair nested in the dead stub near the blind. Photographed by Lawrence H. Walkinshaw on June 13, 1948.

possible of his original territory. These battles sometimes lasted for two or three days. One male would chase another, back and forth, up and down, through the vegetation, until both were thoroughly tired. Often they stopped to rest but almost as quickly started again—sometimes switching roles of pursuer and pursued. Eventually territorial boundaries were established and regular battles were discontinued. In territories along the river bank, regardless of how irregular the stream, the males battled more for the river bank than for the portion of the territory back in the dry woods. In areas where the river almost encircled land, one male nearly always controlled the encircled land.

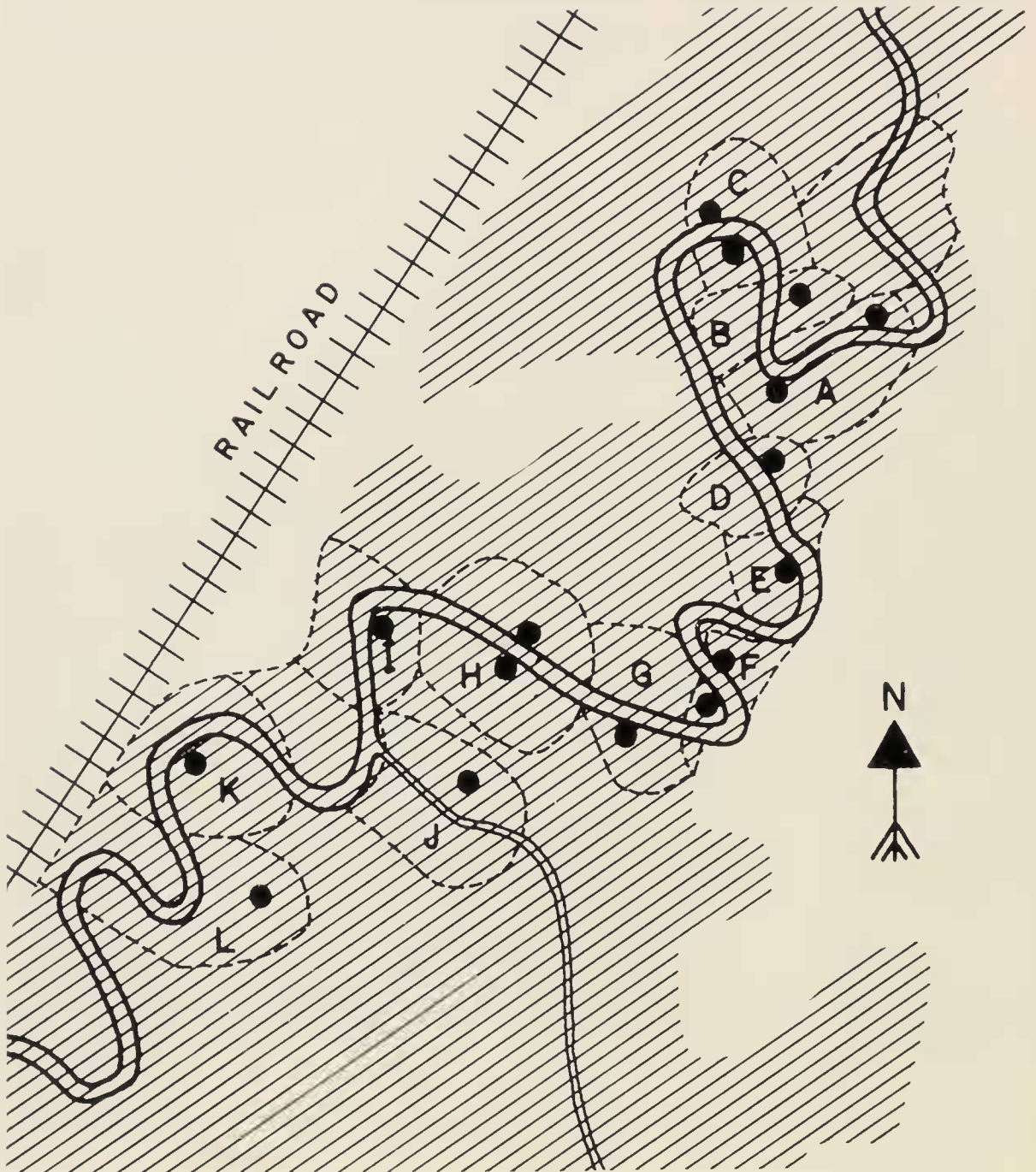


FIG. 2. Nesting territories (enclosed by dotted lines) of the Prothonotary Warbler along the Battle Creek River, Michigan, in 1941. The shaded portion represents bottom-land woods; black circles represent nests. Figs. 3-7 reproduce the same area.

The male almost always selected the first nesting site before the female arrived. Often he carried a mass of moss for the base of the new nest into the bottom of the selected cavity. When the female arrived, she completed the nest shortly and a few days usually intervened before egg laying began.

Often a nesting site was selected first and then territory established around it. An example of this occurred in Tennessee at a bird house used during

the summer of 1939 by three different pairs of banded Prothonotaries, all of which reared young. The first pair used the house from April 18 until May 24; the second pair, May 30 to June 24; the third pair, from early July until early August. The first pair disappeared after nesting; the second pair moved about 150 meters to a new site after nesting in the bird house; the nesting site of the third pair prior to their nesting in the bird house was not known.

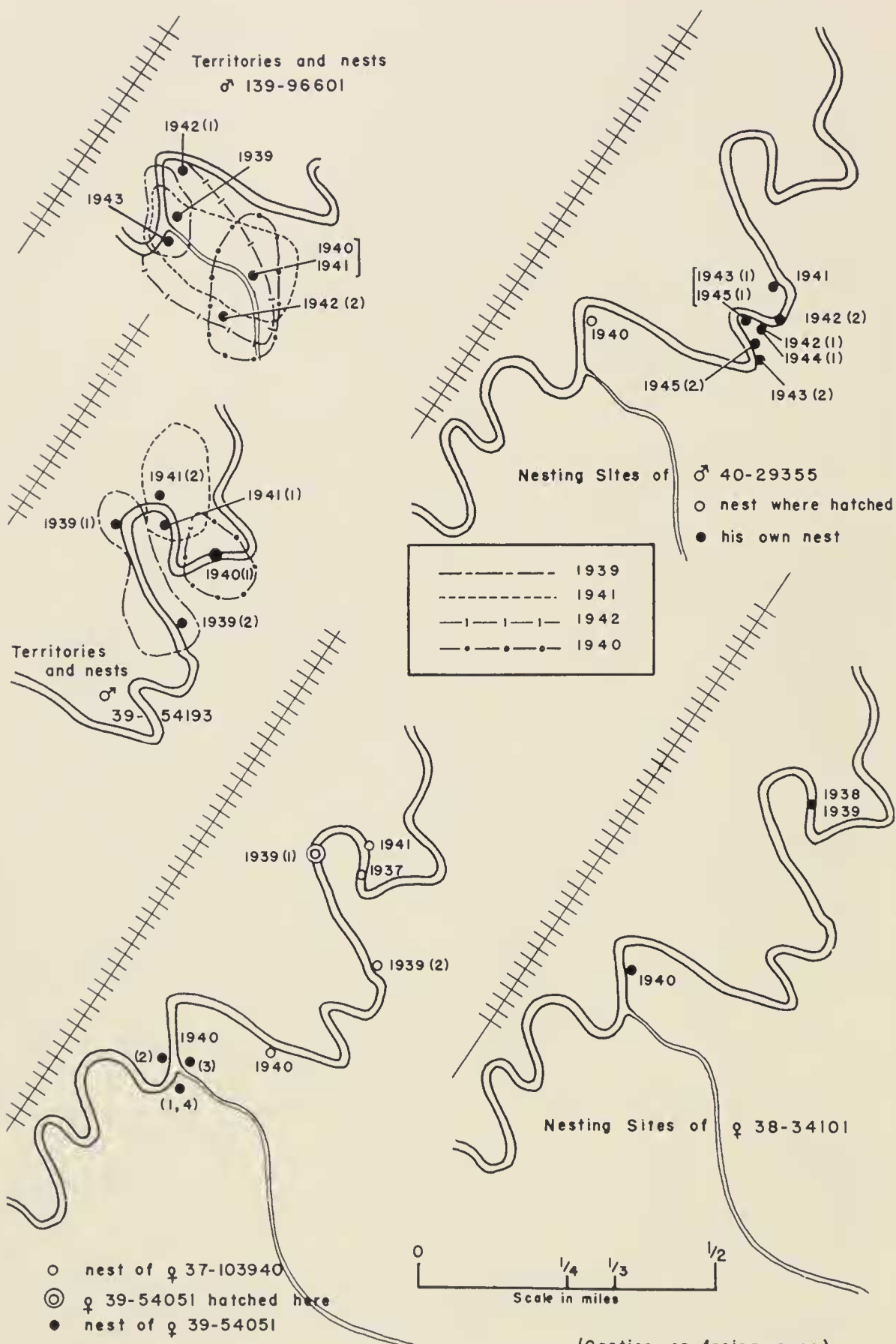
In the Michigan study area the following Prothonotary Warblers nested during the seven summers: 1937, 11 pairs; 1938, 12; 1939, 15; 1940, 19; 1941, 13; 1942, 14; 1943, 14—an average of 14 pairs per year. In 1941 (Fig. 2) the approximate sizes of territories were recorded, averaging for the 13 pairs 3.66 acres (148 ares) per pair with extremes of 1.90 and 6.38 acres (76.8 to 258 ares). Some territories were much larger in total extent, but the entire area was not used at one time. During 1942, male 139-96601 had a territory of 12.41 acres (5.02 hectares) only part of which was used at one time (Fig. 3). Two nests found on this area in 1942 were 1366 feet (412 meters) apart. His 1943 nest, the last one which I found, was only 15 feet (4.9 meters) from the first one found during 1939. His territories during the five summers averaged 9.46 acres (3.82 hectares) in size with extremes of 6.36 and 12.42 acres. The 1940 and 1941 nests were in the same site. Portions of his first year's territory were used each successive year except 1940.

Another male, 40-29355, was banded as a nestling June 16, 1940 (Fig. 4). A nest found during 1941 probably belonged to him. The female was banded, but the male was not captured. It was this male, however, that occupied that territory during the next four summers. He was captured in 1942 and marked with a colored band. His territories were much more concentrated than the territories of no. 139-96601. The entire group covered no more than six acres. His territory size averaged for the four summers 3.16 acres (127.8 ares). The greatest distance between his nests was 491 feet (148.3 meters) during that period.

Male 39-54193 had a different type of territory each year for three years (Fig. 5). The three territories bordered on each other, but barely overlapped. The greatest distance between any of his nests during the three year period was 1226 feet (370 meters).

Male 38-34107 had territories almost equal in size, which overlapped, in 1938 and 1939, but in 1940 he had moved from 990 to 1688 feet (296 to 510 meters) downstream.

Females returned less often than males. If a female's old mate had returned and had a new mate when she arrived, she was forced to mate with a new male. Only one pair remated for the second season, nesting in the same bird



(Caption on facing page)

house in 1938 and 1939. Three other pairs could have remated but did not. The two males returning for five years had different mates each summer. None of their mates was found a second year.

Female 37-103940 was banded in 1937 but in 1938 I did not find her. Every female on the study area was identified but she could have nested a quarter mile or less outside and not have been found. In 1939 she first nested 537 feet (162 meters) from where she nested in 1937. Her second 1939 nest was 934 feet (282.4 meters) from the first 1939 nest. In 1940, she nested 1371 feet (417 meters) downstream and in 1941, 2423 feet (732 meters) upstream from the 1940 nest, but only 211 feet (64 meters) from her 1937 nest (Fig. 6).

GENERAL LIFE HISTORY

The early dates of egg-laying and hatching and the time that the young left the nest were given in *The Wilson Bulletin* (1941, 53:6-11). An interesting correlation was found between the average weight of the eggs and the average number of eggs in a set. If one was greater during a year, the other was less, so that the total weight of each set averaged almost the same each year (Tables 2 and 3). I have studied the records of nests in Michigan where the incubation period was known, but find that air temperature apparently had no effect on the length of this period. All incubation periods (*i.e.*, the period between the laying of the last egg and its hatching) were from 12 days to slightly under 14 days. The highest mean temperature during one of these incubation periods at Battle Creek was 71.8°F., May 26 to June 8, 1939. The same incubation period was found for two nests when the mean temperature was the lowest recorded, 61.1°F., May 27 to June 9, 1938. The two shortest incubation periods, 12 days each, occurred when the mean temperatures were 67.0° and 66.5°F., respectively. Thus, at 17 recorded nests, 1937 through 1941, no correlation was found between incubation period and air temperature.

Notes taken at a nest found along the Battle Creek River on June 6, 1948 (see Fig. 1) record the typical home life of the Prothonotary Warbler. The nest contained at least five eggs. It was over the river in a Downy Woodpecker hole in a dead maple about two meters above the water level. The tree was about 34.5 centimeters thick. The territory of the male extended upstream about 50 meters and about the same downstream. He often penetrated inland about the same distance, on either side of the river, but the

FIGS. 3-7 (opposite page). Nesting of Prothonotary Warbler along Battle Creek River, Michigan. Fig. 3, upper left; Fig. 4, upper right; Fig. 5, middle left; Fig. 6, lower left; Fig. 7, lower right. Symbols in the box are the key to identification of nesting territories.

TABLE 1
BREEDING SEASON OF PROTHONOTARY WARBLER IN MICHIGAN †

Year	Record of first male	First April or May day with 70° temperature	Date of first egg	Temperature 4-5 days prior laying of first egg (day in par.)			Termination of last nesting	Number of days between first laid egg and termination of last nesting	
				Date	High	Low		Actual	Possible
1937	May 11*	May 2	May 22	(17)	67°	43°	July 14	53	69
1938	April 27	April 12	May 8	(3)	90°	64°	July 7	60	80
1939	April 26	April 23	May 18	(13)	67°	39°	July 6	49	69
1940	May 6	April 28	May 22	(18)	67°	36°	July 14	53	73
1941	April 29	April 10	May 15	(10)	64°	34°	July 12	58	69
1942	April 29	April 14	May 10	(5)	61°	34°	July 6	57	—
1943	May **	April 24	May 25	(21)	69°	47°	July 1+	37+	—
1944	May 14	April 23	May 20	(15)	87°	55°	-----	—	—
1945	May 6	April 9	May 19	(14)	61°	38°	July 10	52	59
1946	May 1	April 14							
1947	May 11								
1948	May 9		May 23	(18)	69°	46°	July 8	46	—
Mean	May 4	April 19	May 18		70°	43°	July 8	53	69

† Temperatures used under headings 3 and 5 are those recorded at the Battle Creek Weather Station. Under the last heading are two figures: the first shows the number of days between the laying of the first egg and the termination of the last nesting; the second, the possible number of days if the last nest had not been destroyed.

* Recorded by Mr. and Mrs. N. T. Peterson.

** First Prothonotary not back by May 5 after which I was not able to visit area until May 25.

majority of his time was spent on the river banks or in the trees above the river. When I found the nest both male and female Prothonotary Warblers were scolding a female Cowbird (*Molothrus ater*) that was in the nest area and both were trying to drive her away. When the Cowbird left, the male Prothonotary began to sing. About 85 per cent of his song perches were in the shade and about 15 per cent in the open. Some were over the river, some over land, and only one was more than 50 meters from the nest. Song perches at heights in meters listed were used in the following order: 1.83, 1.22, 3.35, 6.7, 7.5, 8.4, 9.1, 10.6, 9.6, .9, 3.6, 4.5, 5.4, 6.7, and 8.4.

When the female left the nest she usually uttered a rapid, sharp chipping. Often the male was silent while she was away from the nest, but started singing when she returned. While she was away he often stayed within five meters of the nest and at times was observed looking into the nest cavity. Often when she returned to the nest, she chipped considerably and he answered with a sharp *zip-zip*. One noon the song sequence of the male was timed. He sang the regular *tweet-tweet-tweet-tweet-tweet* song. The number of *tweets* was listed in each song for some time as: 12, 9, 11, 11, 10, 10, 10, 10,

TABLE 2
SIZE OF PROTHONOTARY WARBLER EGGS

Year	Number of eggs	Average length in mm.	Average width in mm.	Average weight in gm.
1937	78	18.47	14.55	2.07
1938	40	18.68	14.8	2.11
1939	31	18.33	14.88	2.07
1940	47	18.68	14.75	2.12
1941	31	17.74	14.67	1.99
1942	7	18.04	14.35	—
1943	17	17.51	14.48	2.00
1944	18	17.31	14.26	2.00
1945	28	18.01	14.32	2.03
Mean	297 total	18.26	14.62	2.06

TABLE 3
NUMBER AND WEIGHT OF
PROTHONOTARY WARBLER EGGS

Year	Number of sets	Average number of eggs per set	Average weight of set in grams
1937	16	5.06	10.4742
1938	18	4.94	10.4234
1939	13	5.07	10.4949
1940	15	4.93	10.4516
1941	13	5.15	10.2485
1942	5	5.20	—
1943	6	5.33	10.6600
1944	3*	6.00	12.0000
1945	5**	4.80	9.7444
Mean	94 total	5.07	10.4531

* Early sets only.

** All late sets.

8, 8, 10, 10, 10, 10, 10, 9, 9, 9, 8, 10, 7, 9, 8, 10, 9, 10, 11, 10, 11, 9. There followed a whisper song, and then a song of 8 *tweets*. During a period of seven minutes he sang per minute, 3, 2, 1, 3, 3, 4, and 1 times. During early morning hours males often gave 7 or 8 songs per minute.

The female, on leaving the nest, flew some distance directly away; as a rule, 135 to 150 meters downstream, but less often upstream, and occasionally inland. Sometimes after feeding she preened for a few minutes. The male at times fed her on the nest as she incubated, but most of her feeding was done away from the nest. Between 9:45 a.m. and 4:00 p.m. on June 6, 1948, she spent 303 minutes on the nest and 73 minutes away (Table 4).

In 1948 the following species of birds were nesting or singing on the 88-acre river area where this pair of Prothonotary Warblers nested. Numbers of pairs as given varied little for the entire period of study, 1937-1945: Wood Duck (*Aix sponsa*), 1 pair; Red-shouldered Hawk (*Buteo lineatus*), 1; Yellow-billed Cuckoo (*Coccyzus americanus*), 1;

TABLE 4
ATTENTIVENESS OF FEMALE PROTHONOTARY WARBLER
DURING INCUBATION, JUNE 6, 1948

Female on nest	Time in minutes	Female off nest	Time in minutes
9:45 a.m.—10:51 a.m.	66	10:51 a.m.—11:10 a.m.	19
11:10 a.m.—12:02 p.m.	52	12:02 p.m.—12:17 p.m.	15
12:17 p.m.— 1:15 p.m.	58	1:15 p.m.— 1:29 p.m.	14
1:29 p.m.— 2:17 p.m.	48	2:17 p.m.— 2:24 p.m.	7
2:24 p.m.— 3:04 p.m.	40	3:04 p.m.— 3:11 p.m.	7
3:11 p.m.— 3:50 p.m.	39	3:50 p.m.— 4:00 p.m.	11
Total time	303 minutes		73 minutes
Per cent	80.58		19.41

Barred Owl (*Strix varia*), 1; Ruby-throated Hummingbird (*Archilochus colubris*), 1; Belted Kingfisher (*Megaceryle alcyon*), 1; Red-bellied Woodpecker (*Centurus carolinus*), 1; Hairy Woodpecker (*Dendrocopos villosus*), 1; Downy Woodpecker (*Dendrocopos pubescens*), 1; Crested Flycatcher (*Myiarchus crinitus*), 2; Eastern Phoebe (*Sayornis phoebe*), 1; Acadian Flycatcher (*Empidonax virescens*), 1; Wood Pewee (*Contopus virens*), 2; Rough-winged Swallow (*Stelgidopteryx ruficollis*), 1; Black-capped Chickadee (*Parus atricapillus*), 2; Tufted Titmouse (*Parus bicolor*), 2; White-breasted Nuthatch (*Sitta carolinensis*), 1; Brown Creeper (*Certhia familiaris*), 1; House Wren (*Troglodytes aëdon*), 8 (4 nests found); Catbird (*Dumetella carolinensis*), 1; Robin (*Turdus migratorius*), 2; Wood Thrush (*Hylocichla mustelina*), 1; Veery (*Hylocichla fuscescens*), 1; Blue-gray Gnatcatcher (*Poliopitila caerulea*), 1; Starling (*Sturnus vulgaris*), 4; Yellow-throated Vireo (*Vireo flavifrons*), 3; Red-eyed Vireo (*Vireo olivaceus*), 1; Black and White Warbler (*Mniotilta varia*), 1; Prothonotary Warbler (*Protonotaria citrea*), 12 (6 nests found); Golden-winged Warbler (*Vermivora chrysoptera*), 2 (one nest found); Blue-winged Warbler (*Vermivora pinus*), 1; Cerulean Warbler (*Dendroica cerulea*), 3; Louisiana Water-thrush (*Seiurus motacilla*), 4 (one nest found); American Redstart (*Setophaga ruticilla*), 15 (3 nests found); Cowbird (*Molothrus ater*), 4; Scarlet Tanager (*Piranga olivacea*), 1; Cardinal (*Richmondia cardinalis*), 5; Goldfinch (*Spinus tristis*), 3; Field Sparrow (*Spizella pusilla*), 2 (nesting along high bank bordering river); Song Sparrow (*Melospiza melodia*), 8—making a total of 40 species and 105 pairs (210 individuals) on the area of 88 acres—a density of 119 pairs per 100 acres.

The nearest Prothonotary Warblers to the pair studied intensively on June 6, 1948 were 370 meters upstream, but on June 13 another pair moved in about 90 meters upstream and during late May a pair nested 135 meters downstream.

The male vehemently scolded Bronzed Grackles (*Quiscalus quiscula*) which fed in the area but he paid little attention to Red-wings (*Agelaius phoeniceus*) until they were about nine meters from the nest nor was he much excited by other birds that came into the immediate area. Species which came within a meter or two of the nest and were immediately chased were: Black-capped Chickadee, House Wren, Catbird, Robin, Golden-winged Warbler, Mourning Warbler (*Oporornis philadelphia*), Louisiana Water-thrush,

Redstart, Cowbird, Rose-breasted Grosbeak (*Pheucticus ludovicianus*), and Cardinal. The male chased them by darting quickly in their direction. Once a fox squirrel (*Sciurus niger*) was driven away by the male Prothonotary and a male House Wren that nested nearby.

On June 8, 1948, I was back at this nest site again at 4:20 a.m. The male began singing at 4:37 a.m. The morning was cool, the temperature about 53°F., and the sky overcast. The male carried food to the nest for the first time at 4:52 and had made 17 trips to the nest with food by 7:15 a.m. Twelve of them were between 4:52 and 5:29 a.m. After that he sang more and he spent some time scolding and chasing a grackle even when it was 30 meters from the nest. The male was quiet as he approached, but sang immediately after feeding the young. The female made three trips with food. She left the nest for the first time at 5:32 a.m. During four periods she was away from the nest 13, 9, 9, and 8 minutes and brooded the newly hatched young during periods of 23, 18, and 15 minutes. She chipped as she left the nest and chipped considerably more when she neared it on her return. Both birds flew some distance from the nest in search of food.

The following notes were made June 13, 1948, between 12:45 and 3:00 p.m. while I was watching from a blind two meters from the nest: The young were not brooded by the female. Both birds were feeding the young. The male fed them 10 times with an average of 10.4 minutes (2-28) between feedings; the female fed them 9 times with an average of 9.9 minutes (1-25) between feedings. The longest period between feedings was 16 minutes. The male removed excreta six times; the female, twice. The male did considerable singing and sang most often when the nearest neighboring Prothonotary Warbler sang. The young of this pair died during the afternoon because of the excessive heat of the sun beating on their exposed nest site. They were apparently five days old.

In my studies of the Prothonotary Warbler from 1936 through 1948, I followed 178 nestings of which 50 (28.09 per cent) were successful (at least one young raised). Out of 645 eggs, 262 (40.62 per cent) hatched and 191 (29.61 per cent) young left their respective nests. I banded 138 nestlings of which only two have been found in subsequent years. One, a female, nested in the area for one summer; the other, a male, was found the second year after banding and for three additional years.

RETURNS AND LONGEVITY

In 11 years, 1937-1947, 58 adult female and 17 adult male Prothonotary Warblers were banded. These birds were at least one year old when banded and some were probably older. The known age of two nestling returns would be 1.5 years for the female and 5.5 years for the male. Table 5 gives the

TABLE 5
PROTHONOTARY WARBLER RETURNS

	Males	Per cent return	Females	Per cent return	Both sexes	Per cent return
Number banded	18		59		77	
First year return	9	50	12	20.3	21	27.3
Per cent disappeared first year	50		79.7		72.7	
Second year return	4	22.2	6	10.2	10	13.0
Per cent of original number disappearing second year	27.78		10.2		14.3	
Third year return	2	11.1	1	1.7	3	3.9
Per cent of original number disappearing third year	11.1		8.5		9.1	
Fourth year return	2	11.1	1	1.7	3	3.9
Per cent of original number disappearing fourth year	0.0		0.0		0.0	
Fifth year return	0	0.0	0	0.0	0	0.0
Per cent of original number disappearing fifth year	11.1		1.7		3.9	

returns of the adult birds. The two nestlings are entered in this table as one year old. Females did not return to their territories of past seasons nearly so often as males so that the computed survival of males is probably much more accurate and representative. Females often were found some distance from their previous years' nest sites. Banding returns of 18 males known to have lived a total of 35 years indicated that they survived an average of 1.94 years. Since no birds were found dead and none disappeared, except by moving, during the breeding season, I assume that all males died between breeding seasons and probably lived an average of about one-half year additional to the 1.94 years, or 2.44 years. This would be a minimum figure for these adult birds because the ages at which they were banded is not known, except for one bird. Banding returns of 59 females indicate an average age of 1.36 years but again, the females are less prone to return to the previous nesting areas.

HISTORIES OF PAIRS

♂ 38-70502 × ♀ 38-34101 (Fig. 7)

1938 Nest 1

Nest completed May 7; six eggs laid May 8-13; two Cowbird eggs laid May 12; eggs destroyed by some predator May 18; four eggs May 12 weighed 8.7 gm. Female weighed 16.0 grams May 15.

1938 Nest 2

Nest revamped in same site as above nest; five eggs laid May 23-27; one Cowbird egg laid May 25, the same day Prothonotary egg number 1 was found with a bill hole in it. This egg and egg number 2 disappeared May 27; eggs 3 and 4 hatched June 8, egg 5 on June 9; three young left nest June 18 when 1 touched the house. One landed in river where it swam 50-60 feet (15.1-18.1 meters) to shore; both parents fed young June 26. Eggs measured 18.5×14 , 19×15.5 , 19×15.5 , 19×15.5 and 19×15.5 mm. Three eggs weighed 6.4 gm. on May 28.

1939 Nest 1

This pair remated the second year. The male first observed May 9; female building nest May 14 in the site of her two 1938 nests; six eggs laid May 21-26; predator destroyed eggs May 27. Birds not seen during remainder of summer. Eggs measured 18×15 , 18.5×15 , 18×15 , 18×15 , 18.5×15.5 and 18.5×15.5 mm., and weighed 13.2 gm. on May 26.

Unbanded male \times ♀ 38-34101

1940 Nest 1

Nest with five young about two days old found June 12 in rotted portion of a live ash tree along river bank; five young, including male 40-29355, left nest June 21. Eggs probably laid May 24-28.

The following history pertains to 40-29355 (Fig. 4), son of female 38-34101. During the summer of 1941 he was not positively identified but a pair of Prothonotaries used the same territory that he used during the following four summers. The female was banded 41-73211 and her nest with five eggs was found June 15, but these eggs were destroyed by some predator July 3 or earlier. The nest was in a maple stub on the river bank and 18 feet (5.44 meters) above the water.

♂ 40-29355 \times ♀ 41-73373

1942 Nest 1

Found with four eggs June 11; June 25, four young; July 3, young and adults gone. Nest in maple stub which had fallen into river and extended about four feet (1.23 meters) above normal water level.

♂ 40-29355 \times ♀ 41-73269

1943 Nest 1

Nest with two eggs found May 27 in bird house; May 30, nest torn to pieces and eggs gone. House Wren had replaced nest with sticks.

1943 Nest 2

Nest with two young about two days old and three unhatched eggs found June 24; July 1, two young left nest as I photographed them during mid-afternoon when hot sun beat on their stub, a small white ash on river bank. Nest five feet (1.53 meters) above water. Young flew 10 to 18 feet when they left the nest.

♂ 40-29355 × ♀ 140-32248

1944 Nest 1

Female building nest May 14 in nest box; six eggs laid May 20-25; six young hatched about June 8-9; six young left nest about June 17, all banded.

♂ 40-29355 × ♀ 40-29350

1945 Nest 1

Male returned May 6. Nest found in bird house (same house in which this male nested early during 1943, but a different one than that in which he nested during 1944), May 24, containing five eggs and three Cowbird eggs (the box top was ajar as was sometimes found in the spring); eggs probably laid May 18-22; four young Prothonotaries hatched June 4-5; one young Cowbird hatched. Young banded June 14 and left nest June 15.

1945 Nest 2

On June 28 found nest with two eggs in another bird house farther downstream. On July 12, nest was empty and parents could not be found.

Male 40-29355 had a different mate each year and none had been banded previously. These mates laid 32 eggs of which 16 hatched (50.0 per cent) and 12 young (37.5 per cent) left the nest. His mother was known to lay 22 eggs in three summers. Of these eggs, 8 hatched and 8 young (36.4 per cent) left the nest.

♂ 139-96601 × ♀ 39-54195 (Fig. 3)

1939 Nest 1

Nest with five eggs found June 9 (eggs probably laid June 1-5); four eggs hatched June 16 or 17 and four young left the nest June 27 or 28. Nest two and one half feet (76.8 cm.) above ground in rotted top of small dead maple (4 inches in diameter).

♂ 139-96601 × ♀ 40-29312

1940 Nest 1

Nest found July 3 with two newly hatched young and one infertile egg. Eggs probably laid June 16-18. Young left about July 12. Nest two feet (61 cm.) above ground in rotted end of maple stub blown over in bottomland.

♂ 139-96601 × ♀ 41-73204

1941 Nest 1

Nest with five eggs found June 5 in same site as 1940 nest. Still contained five eggs June 15. When I arrived at 2 p.m. June 19 both parents were scolding a pilot black snake (*Elaphe obsoleta*) that was wrapped around the stub and had its head inside the nest. When killed it was found to have swallowed all five young which were about two days old.

♂ 139-96601 × ♀ 40-29310

1942 Nest 1

Found May 15 with one egg and four Cowbird eggs in a semi-open bird house on river bank. Nest destroyed by some predator before June 8.

1942 Nest 2

Found June 21 with five newly-hatched young. One still had pieces of egg shells around it. Four left nest about June 30. Nest eight feet (2.45 meters) above ground in natural hole in six-inch (15.3 cm.) maple.

♂ 139-96601 × Unbanded ♀

1943 Nest 1

Nest found June 17 in natural opening in small maple 18 feet (5.44 meters) above ground. Seven eggs found in nest. Although in good location it was torn to pieces by some predator June 20.

Male 139-96601 had a different mate in each summer for five years. These mates laid 26 eggs of which 16 (61.5 per cent) hatched and 10 young (38.5 per cent) left the nests. Five of the young were eaten by a pilot black snake; another disappeared from its nest.

A female, 37-103940 was banded during 1937. During the four summers I observed her, I was able to capture but one of her mates. During 1938 she did not nest on the study area.

♀ 37-103940 (Fig. 6)

1937 Nest 1

Four eggs laid June 16-19 measured 18×14.5 , 18.5×15 , 19×16 , and 17.5×14.75 mm. and weighed 7.5 gm. She weighed 13.6 gm. June 18. Her nest was flooded June 26.

1939 Nest 1

Five eggs laid May 22-26; three measured 17.5×13.5 , 17.5×14 , and 18×14 mm., and weighed 6.1 gm. Two eggs disappeared, but three hatched and three young left nest June 18-19. Female weighed 16.7 gm. on May 24.

1939 Nest 2

Four eggs laid June 27-30 measured 18×14 , 18×14.5 , 18×15 , and 18×15 mm. and weighed 7.2 gm. Destroyed by predator July 6.

1940 Nest 1

Four eggs laid May 25-28 measured 18×14.5 , 17.5×13.5 , 18×14 , and 17.5×14 mm. and weighed 7.2 gm. Predator devoured eggs June 2. Female weighed 16.0 gm. May 27.

1941 Nest 1

Nest found June 1 with four young and two infertile eggs. The two eggs measured 17×13 and 18×14.5 mm. The six eggs were probably laid May 14-19; four young left nest June 10.

1941 Nest 2

Five eggs laid June 14-18 measured 18×14.8 , 18×15 , 18.2×14.5 , 18.5×15 , and 18.5×15 mm., and weighed 10.6 gm. Nest destroyed by predator July 3.

During the five years that she lived on or near the area I found six nests of female 37-103940 containing 28 eggs of which 7 hatched and 7 young left the nests (25.0 per cent). Her eggs averaged 17.94×14.45 mm. in measurements and 1.93 gm. in weight. During 1940 her daughter nested about one quarter mile downstream from her. Her daughter, 39-54051, during the summer of 1940, laid 11 eggs which averaged 17.8×14.8 mm. in measurements and 2.1 gm. in weight.

Unbanded male \times ♀ 39-54051 (daughter of 37-103940) (Fig. 6)

1940 Nest 1

Three eggs laid in bird house on river bank May 29-31. Nest 1436 feet (434 meters) from nest site in which 39-54051 was hatched June 7 or 8, 1939. Her eggs in this nest all measured 18×14.5 mm., and weighed a total of 6.1 gm. Some predator took the eggs between June 8 and 11.

1940 Nest 2

Found June 16 in rotted portion of maple stub directly across river from nest 1. Three eggs in nest measured 16.8×15 , 17.8×15 , and 18×15 mm. There were also two Cowbird eggs, but all were destroyed by some predator, June 19.

1940 Nest 3

Three eggs laid June 23-25 measuring 18×15 , 18×15 , and 18.8×15 mm., disappeared June 26. Nest two feet (61 cm.) above ground in small maple stub 22 feet (7.1 m.) from nest 1.

1940 Nest 4

Found July 2 with two eggs measuring 18×15 and 17×14.8 mm., which had disappeared July 3. A House Wren had replaced nest with sticks. Nest in same bird house as nest 1.

WEIGHTS AND MEASUREMENTS

Newly hatched Prothonotary Warblers range in weight from 1.1 to 1.9 gm., averaging for 16 individuals 1.84 gm. When one week old they usually weighed more than 12 gm., but gained little more by the time they left the nest at ten or eleven days. Wings measured about 6 mm. at hatching and increased to 51 mm. at 11 days; tarsi from 5 to 19 mm.; exposed culmens from 3 to 9.5 mm.

Sixty-one adult females from Michigan averaged 17.4 gm. (13.6-20.0) in weight; their wings averaged 68.9; exposed culmens, 13.77; tarsi, 18.44 mm. Of 18 males, the average weight was 14.95 (13.6-15.8) gm.; wings, 73.8 mm.; exposed culmens, 14.4; tarsi, 19.6. Wings were measured, unflattened, with a straight-edge ruler from the bend to the tip of the longest primary.

SUMMARY

A nesting study of the Prothonotary Warbler (*Protonotaria citrea*) was made in Calhoun County, Michigan from 1937 to 1948. The study was made in a plot two-thirds of a mile long (1069 meters) and about 88 acres (35.62 hectares) in area, along the Battle Creek River.

Of 84 nests, 29 were over standing water, 32 over running water or its edge, and 23 over dry land. The latter were from .61 to 137.8 meters from the river bank. Of the 84 nests, 43 were in natural openings and 41 in woodpecker holes, usually those formerly used by the Downy Woodpecker. Forty-one nests were from 61 to 152 cm. above ground or water; 21 from 152 to 304, and 20 from 304 to 450: two nests were still higher, the highest being 10.4 meters above ground.

Males usually selected the first nest site and often carried moss into the opening before the arrival of the female. Battles over territory often lasted several days. A nest site was often selected and territory established around it.

In Michigan, an average of 14 pairs nested on the 88 acres from 1937 through 1943. In 1941, the average size of territory was 3.66 acres (148 ares) with extremes 1.9 and 6.38 acres (76.8 and 258 ares). Smallest were three territories each of about 1.9 aeres.

Two males were studied in detail through five summers of nestings. One, 139-96601, had two nests 412 meters apart during 1942, but in the five summers occupied an area of about 9.46 aeres (3.82 hectares). The other male, 40-29355, banded as a nestling, returned to use an area of about six acres during four summers, the average size per summer being about 3.16 acres (127.8 ares). A third male had a different territory for each of three summers while yet another had two that overlapped in different years, then a different one the third year. Females returned less often. One female lived at least five years, but was found during only four. She apparently had a new mate each summer as did the two males for which I have five-year records. The greatest distance between her nests of 1937, 1939, 1940, and 1941 was 2423 feet (732 meters).

During 10 summers the average date of arrival of the first male was May 4 (April 26-May 14): the average date of the first laid egg, May 18 (May 8-25); and the termination of the last nesting, July 8 (July 6-14). The average measurement of 297 eggs was 18.26×14.62 mm., and the average weight, 2.06 gm. The average number of eggs in 94 sets was 5.07 (3-7) and the average set weight, 10.45 gm. First sets of eggs are larger, as demonstrated earlier (Walkinshaw, 1941. *Wilson Bull.*, 53:10).

The female does the incubating, but at times is fed by the male. Usually she leaves the nest to receive food. During 376 minutes at a nest in 1948, the female incubated 303 minutes (80.6 per cent) of the time, in periods of from 39 to 66 minutes duration. Inattentive periods (19.4 per cent) varied from 7 to 19 minutes. The male usually sang less than 50 meters from the nest; 85 per cent of his perches were in the shade and were from 1.22 to 10.6 meters above the ground or water. Rates of singing in the early morning are 7 to 8 songs per minute; during mid-day, 1 to 4. The number of syllables varied from 7 to 12. In 1948, a total nesting census was made. Forty species of birds and 105 pairs nested on the 88 aeres—a density of 119 pairs per 100 acres.

Male Prothonotary Warblers have been observed to chase all birds that came within a few feet of their nests. Near one nest Bronzed Grackles were scolded much more than other birds, and squirrels also were chased away.

On June 8, 1948, a male Prothonotary began to sing at 4:37 a.m. The female left the nest for the first time at 5:32 a.m. and the male made 17 trips with food to the newly hatched young while the female made three between 4:52 and 7:15 a.m. The female left the nest for four periods averaging 9.7 minutes (8-13) and remained on the nest an average of 18.6 minutes (15-23). On June 13, between 12:45 and 3:00 p.m., the female did not brood the young; the male fed ten times with an average of 10.4 minutes (2-28) between feedings; the female fed nine times and averaged 9.9 minutes between feedings (1-25).

Of 178 Michigan nests, 50 (28.1 per cent) were successful in that at least one young left the nest. Of 645 eggs, 262 (40.6 per cent) hatched and 191 (29.6 per cent) young left the nest. Two of 138 banded nestlings returned the next year. One returned one year; the other, five. In 11 years, 1937-1947, 58 adult females were banded. Based on returns, the average age of these birds was at least 1.86 years. Males were more faithful in returning to past years' territories. Eighteen were banded of which nine returned the first year, five the second, two the third, and two the fifth.

One pair of Prothonotaries nested twice in the same bird house in 1938 and once in 1939. The female mated with a new male during 1940. In three summers she was known to produce eight young from 22 eggs. One of these, a male, apparently had a different mate each year for five summers. His mates laid at least 32 eggs of which 16 hatched and 12 left their nests. Another male was observed for five summers and had a new mate each year. His mates were found to lay 26 eggs, hatching 16, and 10 young left the nest. A pilot black snake devoured five of their young.

During four summers I observed 21 eggs of one female which averaged 17.94×14.45 mm. in size and 1.93 gm. in weight. One summer her daughter, when one year old, laid 11 eggs averaging 17.8×14.8 mm. and 2.1 gm.

Newly hatched Prothonotaries range in weight from 1.1 to 1.9 gm. (average, 1.84 gm.). When they left the nest at 10 or 11 days of age they weighed over 12 gm. Sixty-one females averaged 17.44 gm. (13.6 to 20.0) in weight; 18 males averaged 14.9 (13.6 to 15.8) gm. Wings of the females averaged 68.9 mm.; exposed culmens, 13.8 mm.; tarsi, 18.4 mm. In the males, wings averaged 73.8; culmens, 14.4; and tarsi, 19.6 mm.

1703 WOLVERINE TOWER, BATTLE CREEK, MICHIGAN, JANUARY 19, 1952